Effects Evoked from the Rubrospinal Tract in Cats

Stimulation of the red nucleus evokes excitatory action in flexor motoneurones[1]. Anatomical studies have revealed that the rubrospinal tract terminates mainly in Rexed's layer VII and layer VI[2]. Because of the latter termination, it was of interest to investigate the effect on transmission in spinal reflex paths. The corticospinal tract which also terminates in layer VI[3] gives excitatory action to interneurones of spinal reflex paths, and it has been postulated that the action in motoneurones is secondary to excitation of the interneurones of spinal reflex paths[4].

In experiments on cats anaesthetized with chloralose, the red nucleus was stimulated through a tungsten microelectrode with a tip diameter of about 5 μ. For location of the electrode the rubrospinal tract was stimulated antidromically in the mid-lumbar region and the electrode inserted to the site of maximal antidromic cell field potential. At the end of the experiment an electrolytic lesion was made through the electrode and the location of the tip of the electrode checked histologically.

Intracellular recording revealed that EPSPs or IPSPs may be evoked from the red nucleus in both flexor and extensor motoneurones, but it was confirmed that EPSPs dominate in flexor motoneurones. The shortest latency of either action is about 4.5 msec, indicating a disynaptic linkage.

The effect from the red nucleus has been investigated on transmission from different primary afferent systems to motoneurones. It is a regular finding that transmission of the Ia IPSP is facilitated (Figure 1, A–C). There is also facilitation of transmission from Ib afferents as illustrated for the Ib inhibitory pathway in D–F (Figure 1). Spatial facilitation between the rubrospinal tract and some pathways from low threshold cutaneous afferents is common. The excitatory action from the central pad to motoneurones of plantar muscles[5] is facilitated from the red nucleus and the same effect is often found on actions to flexor and extensor motoneurones by low threshold afferents from other cutaneous regions. The synaptic actions evoked in motoneurones by stronger stimulation of cutaneous nerves, on the other hand, may be inhibited, and the same holds true for the synaptic actions from high threshold muscle afferents and high threshold joint afferents. Hence inhibition of the pathway from the FRA (flexor reflex afferents) seems to be rather common, but in a few cases facilitation has been met. This inhibition cannot entirely be due to primary afferent depolarization

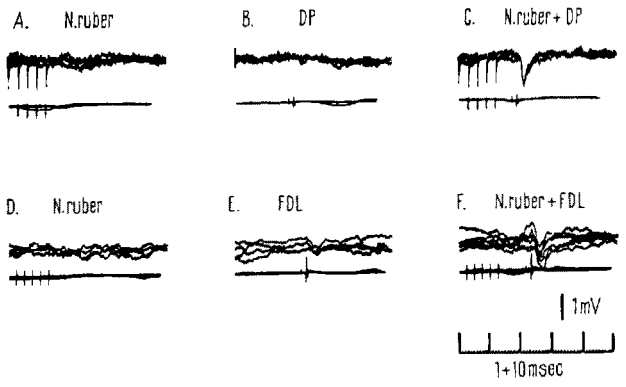

Fig. 1. The upper traces are intracellular recordings (internal negativity being signalled upwards) from 2 gastrocnemius-soleus motoneurones. The lower traces are recorded from the L7 dorsal root entry zone. In B and C a submaximal group I volley is evoked in the antagonist deep peroneal nerve (DP) and is without effect in B but gives a large IPSP in C when combined with stimulation of the red nucleus (N. ruber), which is stimulated alone in A. In the corresponding lower records, D-F is shown facilitation from the red nucleus of the IPSP evoked by a maximal group I volley in the nerve from flexor digitorum longus (FDL). In C there is facilitation of the reciprocal Ia inhibitory pathway in F facilitation of the Ib inhibitory pathway. All records consist of superimposed traces.

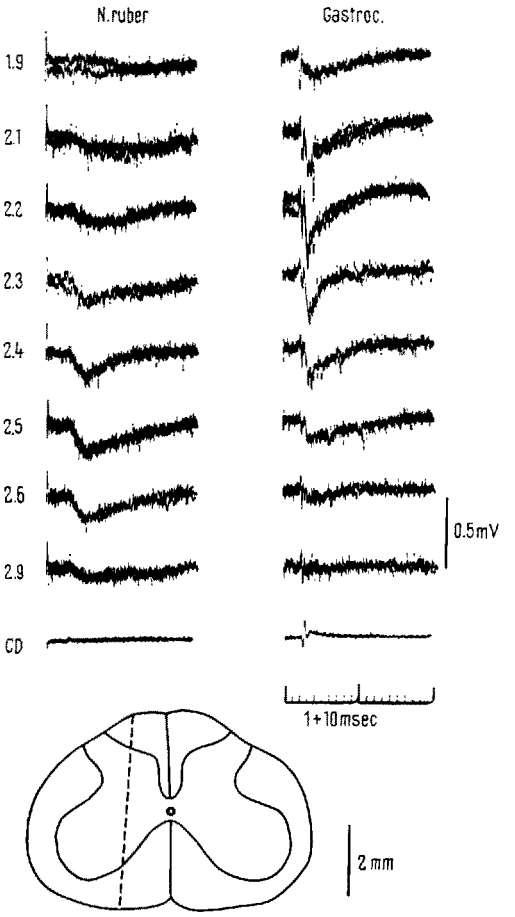

Fig. 2. Microelectrode records (negativity signalled downwards) of the focal potentials generated by a single stimulus in nucleus ruber (left record) and by the maximal group I volley in the gastrocnemius-soleus nerve (Gastroc.). The electrode track is shown in the drawing and the corresponding records were taken at the depths given for each pair in mm below the surface of the dorsal column. Lower traces were obtained from the L7 dorsal root entry zone. The left lower record shows the arrival of the volley in the rubrospinal tract and the right the arrival of the Gastroc. group I volley to the L7 segment. All records consist of superimposed traces.

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since it occurs before the onset of the dorsal root potential that can be evoked from the red nucleus.

Recording of the extracellular field potential that is evoked in the spinal cord from the red nucleus shows a monosynaptic focal potential in Rexed's layer VI and VII, which indicates that the rubrospinal tract has monosynaptic connections with neurones in this region. This is illustrated in Figure 2 by the left records showing a maximal monosynaptic focal potential at a depth of 2.5–2.6 mm. For comparison it is shown in the corresponding right records that the focal potential evoked monosynaptically from group I muscle afferents is maximal at a depth of 2.2 mm, which is in the intermediate nucleus in layer VI[6]. Extra- and intracellular recording from interneurones in the dorsal horn and intermediate region has revealed excitatory action from the red nucleus on interneurones monosynaptically activated by Ia or Ib afferents. Among the interneurones activated from the FRA, two types are found: some interneurones are facilitated, others are inhibited from the rubrospinal tract. In layer VII, ventral to the intermediate nucleus, interneurones are found that can be excited from the red nucleus but not from primary afferents. It does not seem likely that the strong excitatory action that is evoked from the rubrospinal tract in flexor motoneurones can be explained by the excitation of interneurones in reflex pathways. It is more likely that flexor excitation is mediated via those interneurones in layer VII that are activated from the rubrospinal tract but not from primary afferents.

The importance of the supraspinal control of transmission in reflex pathways for motor regulation is emphasized by the finding that facilitation through excitatory action on interneurones of reflex paths can be evoked both from the corticospinal and rubrospinal tracts. It is postulated that the rubrospinal action is governed from cerebellum.

Résumé. La stimulation du Noyau Rouge a pour effet une facilitation des interneurons intercalés entre des afférences primaires et les motoneurons et provoque dans les motoneurons des potentiels postsynaptiques bisynaptiques.

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Tests for an Anti-Insulin Factor in the Plasma of Insulin-Tolerant Mice

Mice of the selected inbred KLC57 Black strain can tolerate from 200 to 500 units of insulin without convulsing, while mice of the BUB strain convulse with much smaller amounts, usually 20 units or less[1–3]. In a preliminary study, SNEDECOR[4] found that serum from mice of the tolerant strain mixed with insulin in vitro produced a lowering of the blood sugar when injected into a non-tolerant mouse. Further study of the tolerant and non-tolerant strains was undertaken to see if differences between the strains could be detected in hemagglutination reactions as an indication of possible antibodies to insulin, and to determine, by means of bioassay, insulin activity after contact of the insulin with serum of tolerant animals in vivo and in vitro.

KL and BUB strains of mice were derived from insulin tolerant and insulin sensitive strains at Brown University and have been maintained as inbred strains at the University of Rhode Island since 1960. The mice were maintained in special animal quarters at 77°F, 50% humidity, and 12 h of light per day. Purina Laboratory Chow and water were available ad libitum. Each KL animal was tested at 40 days of age with 200 units of insulin (except in Groups B and C, Table); surviving animals were used for matings and experiments. All insulin used was Iletin (Lilly) purchased as U 40 or U 500 preparations. All injections were intraperitoneal. All tests were run between 9 p.m. and 3 a.m. A total of 28 KL and 38 BUB mice was used.

For hemagglutination tests, blood obtained from the sub-orbital sinus by means of a capillary pipette was allowed to remain at room temperature until clotting began and was then refrigerated for 18–20 h. The blood clot was removed and the plasma remaining was centrifuged at

In vivo assay

Test	Description of injections	Number of BUB animals	Time after injection, min	Blood sugar (average) mg%
Insulin control	10 U insulin	2	0	125
			20	31
			40	20
			70	15
			110	moribund
Plasma control	0.5 ml KL plasma	2	0	100
			20	125
			40	125
			70	125
			110	125
Test A	0.5 ml plasma of KL mice injected with 40 U insulin 2 h previously	4	0	120
			25	40
			50	dead
Test B	0.5 ml KL plasma; challenge with 10 U insulin 5 min later	3	0	120
			35	40
			60	20
			90	dead
Test C	0.5 ml KL plasma treated with 10 U insulin in vitro for 10 min	3	0	100
			20	40
			45	40
			75	20
			115	dead

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